

Name: _____



Which sequence represents a correct order of historical developments leading to the modern model of the atom?

- A) most of the atom is empty space → the atom is a hard sphere → electrons exist in orbitals outside the nucleus
- B) most of the atom is empty space → electrons exist in orbitals outside the nucleus → the atom is a hard sphere
- C) the atom is a hard sphere → electrons exist in orbitals outside the nucleus → most of the atom is empty space
- D) the atom is a hard sphere → most of the atom is empty space → electrons exist in orbitals outside the nucleus

2) Which statement *best* explains why most atomic masses on the Periodic Table are decimal numbers?

- A) Atomic masses are a weighted average of the naturally occurring isotopes.
- B) Atomic masses are an estimated average of the artificially produced isotopes.
- C) Atomic masses are determined relative to an H-1 standard.
- D) Atomic masses are determined relative to an O-16 standard.



An atom of oxygen is in an excited state. When an electron in this atom moves from the third shell to the second shell, energy is

- A) absorbed by the nucleus
- B) emitted by the electron
- C) emitted by the nucleus
- D) absorbed by the electron

4) Which statement *best* describes electrons?

- A) They are positive subatomic particles and are found in the nucleus.
- B) They are negative subatomic particles and are found in the nucleus.
- C) They are negative subatomic particles and are found surrounding the nucleus.
- D) They are positive subatomic particles and are found surrounding the nucleus.

5) Which statement is true about a proton and an electron?

- A) They have the same masses and different charges.
- B) They have different masses and the same charges.
- C) They have different masses and different charges.
- D) They have the same masses and the same charges.

6) How many electrons are in an Fe^{2+} ion?

- A) 56
- B) 24
- C) 26
- D) 28



7) What is represented by the dots in a Lewis electron-dot diagram of an atom of an element in Period 2 of the Periodic Table?

- A) the number of neutrons in the atom
- B) the total number of electrons in the atom
- C) the number of protons in the atom
- D) the number of valence electrons in the atom

8) What is the total number of electrons found in an atom of sulfur?

- A) 32
- B) 16
- C) 6
- D) 8

9) Which symbol represents a particle with a total of 10 electrons?

- A) Al
- B) N^{3+}
- C) N
- D) Al^{3+}

10) Atoms of the same element that have different numbers of neutrons are classified as

- A) isotopes
- B) isomers
- C) charged nuclei
- D) charged atoms

11) What is the total number of electrons in the outermost shell of a phosphorus atom in the ground state?

- A) 1
- B) 2
- C) 3
- D) 5

12) The nucleus of an atom of cobalt-58 contains

- A) 59 protons and 60 neutrons
- B) 27 protons and 31 neutrons
- C) 60 protons and 60 neutrons
- D) 27 protons and 32 neutrons

13) As an atom becomes an ion, its mass number

- A) remains the same
- B) increases
- C) decreases

14) The modern model of the atom shows that electrons are

- A) found in regions called orbitals
- B) orbiting the nucleus in fixed paths
- C) located in a solid sphere covering the nucleus
- D) combined with neutrons in the nucleus

15) The atomic mass of element A is 63.6 atomic mass units. The only naturally occurring isotopes of element A are A-63 and A-65. The percent abundances in a naturally occurring sample of element A are *closest* to

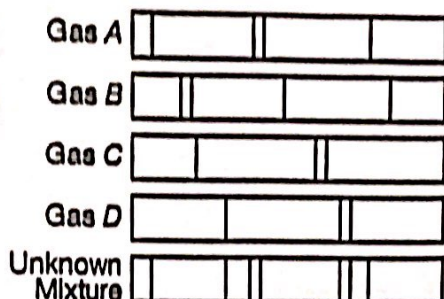
- A) 100% A-63 and 0% A-65
- B) 50% A-63 and 50% A-65
- C) 69% A-63 and 31% A-65
- D) 31% A-63 and 69% A-65

16) When compared with the energy of an electron in the first shell of a carbon atom, the energy of an electron in the second shell of a carbon atom is

- A) the same
- B) greater
- C) less

Questions 26 and 27 refer to the following:

Many advertising signs depend on the production of light emissions from gas-filled glass tubes that are subjected to a high-voltage source. When light emissions are passed through a spectroscope, bright-line spectra are produced.



26) Explain the production of an emission spectrum in terms of the energy states of an electron.

27) Identify the *two* gases in the unknown mixture in the given diagram.

28) John Dalton was an English scientist who proposed that atoms were hard, indivisible spheres. In the modern model, the atom has a different internal structure.

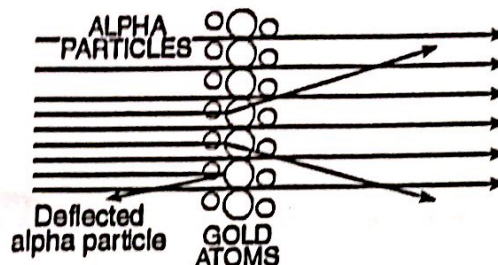
- (a) Identify *one* experiment that led scientists to develop the modern model of the atom.
- (b) Describe this experiment.
- (c) State *one* conclusion about the internal structure of the atom, based on this experiment.

29) Describe, in terms of subatomic particles found in the nucleus, *one* difference between the nuclei of carbon-12 atoms and the nuclei of carbon-13 atoms. [The response must include both isotopes.]

Questions 30 through 32 refer to the following:

One model of the atom states that atoms are tiny particles composed of a uniform mixture of positive and negative charges. Scientists conducted an experiment where alpha particles were aimed at a thin layer of gold atoms.

Most of the alpha particles passed directly through the gold atoms. A few alpha particles were deflected from their straight-line paths. An illustration of the experiment is shown below.



30) A few of the alpha particles shown in the diagram were deflected. What does this evidence suggest about the structure of the gold atoms?

31) How should the original model be revised based on the results of the experiment shown in the diagram?

32) According to the diagram, most of the alpha particles passed directly through the gold atoms undisturbed. What does this evidence suggest about the structure of the gold atoms?

Questions 33 and 34 refer to the following:

Element	Electron Configuration
X	2-8-8-2
Y	2-8-7-3
Z	2-8-8

33) What electron configuration represents the excited state of a calcium atom?

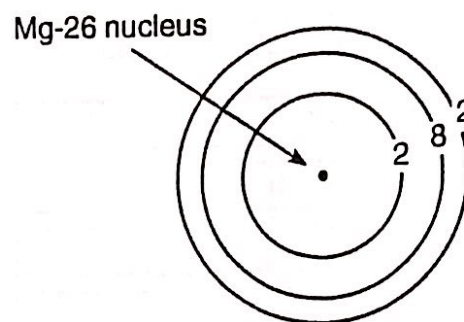
34) What is the total number of valence electrons in an atom of electron configuration X?

- 35) The table below gives information about two isotopes of element X .

Isotope	Mass	Relative Abundance
X-10	10.01	19.91%
X-11	11.01	80.09%

Calculate the average atomic mass of element X . [Show a correct numerical setup. Express your answer to the correct number of significant figures.]

- 36) The diagram below represents an atom of magnesium-26 in the ground state.



According to the diagram, what is the total number of valence electrons in an atom of Mg-26 in the ground state?

- 1) D 2) A 3) B 4) C 5) C
 6) B 7) D 8) B 9) D 10) A
 11) D 12) B 13) A 14) A 15) C
 16) B 17) A 18) C 19) C 20) D
 21) C 22) D 23) C 24) A 25) A

26) **SAMPLE ANSWERS:** Energy is released when an electron falls from a high state (excited) to a low state (ground). OR excited state to ground state OR high energy to low energy

27) *A and D*

28) **SAMPLE ANSWERS:** (a) gold foil (Rutherford) OR cathode rays (Thomson) OR electron bombardment (Moseley); (b) In the gold-foil experiment, gold foil was bombarded with alpha particles. Some alpha particles deflected.; (c) The gold-foil experiment shows that an atom is mostly empty space. OR An atom has a small dense core. OR An atom has a positively charged center.

29) **SAMPLE ANSWERS:** Carbon-12 has six neutrons and carbon-13 has seven neutrons. OR Carbon-13 has one more neutron than carbon-12. OR C-12 has $6n$ and C-13 has $7n$.

30) **SAMPLE ANSWERS:** Alpha particles were deflected by the positively charged nucleus OR nucleus — charged

31) **SAMPLE ANSWERS:** The atom has a positively charged nucleus; negative electrons surround the outside. OR The positive charges are in the nucleus; electrons are not mixed in the nucleus. OR nucleus smaller than atom

32) **SAMPLE ANSWERS:** The atom is mostly empty space. OR The volume of the atom is mostly unoccupied.

OR 2-8-7-3

34) 2

35) 10.81

WORK SHOWN: $\frac{(19.91)(10.01) + 80.09(11.01)}{100}, (0.1991)(10.01) + (0.8009)(11.01) = 10.81$

36) 2 or two